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ABSTRACT

This lesson guide for instruction of students in grades 3-5 contains activities in mathematics, science, and technology. The NASA "Why?" Files is a series of instructional programs consisting of broadcast, print, and online elements. Emphasizing standards-based instruction, Problem-Based Learning, and science as inquiry, the series seeks to motivate students to become critical thinkers and active problem solvers. Each program supports the national mathematics, science, and technology standards and includes a 60-minute video broadcast, a companion educator's guide, Web-based activities and materials, and information about NASA programs, projects, facilities, and researchers. The materials in this lesson guide relate to aviation design. Included are the relationship of the material to national geography, science, mathematics, and educational technology standards; activities and worksheets; vocabulary lists; and guides to further resources. (MM)

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National Aeronautics and
Space Administration

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Hampton, VA 23681-2199

Educational Product	
Educators	Grades 3-5

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The NASA "Why?" Files
The Case of the "Wright" Invention

A Lesson Guide with Activities in Mathematics, Science, and Technology

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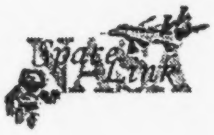

The Case of the "Wright" Invention lesson guide is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA "Why?" Files can be found at the NASA "Why?" Files web site: **http://whyfiles.larc.nasa.gov**

The NASA "Why?" Files
The Case of the "Wright" Invention

A Lesson Guide with Activities in Mathematics, Science, and Technology

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AIAA FOUNDATION Registered users of the NASA "Why?" Files may request an American Institute of Aeronautics and Astronautics (AIAA) classroom mentor. For more information or to request a mentor, e-mail **nasawhyfiles@aiaa.org**.

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Program Overview

When the tree house detectives hear a report on KSNN about a young inventor's contest, they decide it might be their next case. Thus begins *The Case of the "Wright" Invention*.

The tree house detectives are not even quite sure what an invention is, much less how to create one. Seeking some advice, they visit Dr. D, a retired science professor, who helps the tree house detectives understand that the process of invention is similar to the scientific method. Armed with new confidence, they set out to create a "bug" list of ideas to find a problem to solve!

As the tree house detectives learn about inventors, they get a little help from mysterious sources, Orville and Wilbur Wright. The tree house detectives are not sure whether these brothers are real or just actors. The tree house detectives also visit a young inventor, Lindsey Clements, who shows them that even kids can be inventors. NASA researchers and other community experts also help the tree house detectives learn how to plan, design, build, and test their invention. They discover that inventing is not as easy as they thought, even for Orville and Wilbur Wright!

National Geography Standards (grades 3-5)

	Segment			
Standard	**1**	**2**	**3**	**4**
The geographically informed person knows and understands				
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire, process, and report information from a spatial perspective	✖	✖	✖	✖
Environment and Society				
How physical systems affect human systems	✖	✖	✖	✖
Uses of Geography				
How to apply geography to interpret the past			✖	✖

National Science Standards (Grades K - 4)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, orders, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	✖
Science and Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (Content Standard B)				
Properties of objects and materials			✖	
Science and Technology (Content Standard E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology	✖	✖	✖	✖
Abilities to distinguish between natural objects and objects made by humans	✖	✖	✖	✖
Science in Personal and Social Perspective (Content Standard F)				
Personal health	✖	✖	✖	✖
Science and technology in local challenges	✖	✖	✖	✖
History and Nature of Science (Content Standard G)				
Science as a human endeavor	✖	✖	✖	✖

National Science Standards (Grades 5 - 8)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, order, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	✖
Science as Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understanding about scientific inquiry	✖	✖	✖	✖
Physical Science (Content Standard B)				
Properties and changes of properties in matter			✖	
Science and Technology (Content Standard E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (Content Standard F)				
Personal health	✖	✖	✖	✖
Science and technology in society	✖	✖	✖	✖
History and Nature of Science (Content Standard G)				
Science as a human endeavor	✖	✖	✖	✖
Nature of science	✖	✖	✖	✖
History of science	✖	✖	✖	✖

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National Mathematics Standards (Grades 3 - 5)

Standard	Segment 1	2	3	4
Number and Operations				
Understand meanings of operations and how they relate to one another.			✖	
Compute fluently and make reasonable estimates.			✖	
Algebra				
Understand patterns, relations, and functions.			✖	
Use mathematical models to represent and understand quantitative relationships.			✖	
Analyze change in various contexts.			✖	
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.			✖	
Apply appropriate techniques, tools, and formulas to determine measurements.			✖	
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.			✖	
Select and use appropriate statistical methods to analyze data.			✖	
Develop and evaluate inferences and predictions that are based on data.			✖	
Problem Solving				
Build new mathematical knowledge through problem solving.			✖	
Solve problems that arise in mathematics and in other contexts.	✖	✖	✖	✖
Apply and adapt a variety of appropriate strategies to solve problems.			✖	
Monitor and reflect on the process of mathematical problem solving.			✖	
Communication				
Organize and consolidate their mathematical thinking through communication.			✖	
Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.			✖	
Analyze and evaluate the mathematical thinking and strategies of others.			✖	
Representation				
Create and use representations to organize, record, and communicate mathematical ideas.			✖	
Select, apply, and translate among mathematical representations to solve problems.			✖	
Use representations to model and interpret physical, social, and mathematical phenomena			✖	

National Technology Standards (ITEA Standards for Technology Literacy, Grades 3 - 5)

Standard	Segment 1	2	3	4
Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	✖	✖	✖	✖
Standard 2: Students will develop an understanding of the core concepts of technology.	✖	✖	✖	✖
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	✖	✖	✖	✖
Technology and Society				
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	✖	✖	✖	✖
Standard 7: Students will develop an understanding of the influence of technology on history.	✖	✖	✖	✖
Design				
Standard 8: Students will develop an understanding of the attributes of design.	✖	✖	✖	✖
Standard 9: Students will develop an understanding of engineering design.	✖	✖	✖	✖
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	✖	✖	✖	✖
Abilities for a Technological World				
Standard 11: Students will develop the abilities to apply the design process.	✖	✖	✖	✖
Standard 12: Students will develop abilities to use and maintain technological products and systems.	✖	✖	✖	✖
Standard 13: Students will develop abilities to assess the impact of products and systems.	✖	✖	✖	✖
The Designed World				
Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.	✖	✖	✖	✖
Standard 18: Students will develop an understanding of and be able to select and use transportation technology.	✖	✖	✖	✖
Standard 20: Students will develop an understanding of and be able to select and use construction technologies.			✖	✖

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National Technology Standards (ISTE National Educational Technology Standards, Grades 3 - 5)

Standard	Segment 1	2	3	4
Basic Operations and Concepts				
Use Keyboards and other common input and output devices efficiently and effectively.	✖	✖	✖	✖
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Technology Productivity Tools				
Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	✖	✖	✖	✖
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	✖	✖	✖	✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖			

The NASA "Why?" Files
The Case of the
"Wright" Invention

Segment 1

During the lazy days of summer, the tree house detectives are a little "bored." When they hear a KSNN announcement about an invention contest, their interest suddenly peaks. Although they are not quite sure what an inventor does, they remember learning that Orville and Wilbur Wright were famous inventors and decide to research their inventions.

As the tree house detectives begin to read about the Wright brothers, the pages come to life and they discover the brothers earnestly discussing ways to solve the problem of controlling their glider. Wilbur thinks he has finally defined the problem and that they are ready to find a solution. The tree house detectives are now even more curious about this invention stuff and decide to visit Dr. D, who just might help answer their questions.

Dr. D guides the tree house detectives to discover that the invention process is very similar to the scientific method. He explains that to become inventors, they need to think of problems that must be solved. The tree house detectives decide that there is a real need to make bike riding safer. To do that, they need to make bicycles more visible at night. Now that they have defined their problem, they are unsure of their next step.

The tree house detectives solicit the help of a young inventor named Lindsey Clements. Lindsey tells the tree house detectives how she invented a "gumball" machine. Motivated by her success, the tree house detectives decide to "bug" out to learn more about inventors. But wait, they see the Wright brothers again!

Objectives

The student will

- learn the steps of the invention process.
- identify a simple problem.
- understand that scientists use different kinds of investigations, depending on the questions they are trying to answer.
- understand that people have always had problems and have invented tools and techniques to solve them.
- understand that people of all ages engage in a variety of scientific and technological work.

Vocabulary

invention - an original device, idea, or process originated after study and experiment—a discovery or a new finding

invention process - the act or power of inventing; a step-by-step way of inventing

inventor - someone who creates or produces an original device, idea, or process

log - a written record of daily activities kept by an inventor while working on an invention

scientific method - the rules and methods for the pursuit of knowledge that involve finding and stating a problem, the collection of facts through observation and experiment, and the making and testing of ideas that need to be proven right or wrong

wing warping - twisting of the wing by using control cables to induce a gently banked turn that improves the control system, allowing for lateral movement. This original process, invented by the Wright brothers, led to successful flight.

Wright brothers - Orville and Wilbur Wright are credited with being the first to successfully complete a controlled, powered flight of a heavier-than-air airplane with a pilot onboard

Video Component

Implementation Strategy

The NASA "Why?" Files is designed to enhance and enrich the existing curriculum. Two to three days of class time is suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 1 of *The Case of the "Wright" Invention*, read the program overview (p. 11) to the students. List and discuss questions and preconceptions that students may have about inventors and inventions.
2. Record a list of issues and questions that the students want answered in the program. The following tools are available on the web site to assist students in the invention process:

   Problem Board - printable form to create student or class K-W-L Chart

   PBL Questions - questions for students to use while conducting research

   Design Log - printable log for students to record their invention process

   Scientific Process Log - chart that describes the scientific process
3. Focus Questions - questions at the beginning of each segment help students focus on a reason for viewing the broadcast (video). Questions can be printed from the web site to allow students to copy them into their science journals. Remind students to look for the Focus Question icon as the answer to the focus question appears.
4. To create an invention booklet, use pages in each segment marked with an asterisk (*).

2001 - 2002 NASA "Why?" Files Programs

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the "Wright" Invention* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students discuss the focus questions for segment 1 and record answers.
2. Have students discuss and reflect in their science journals the "What's Up?" questions asked at the end of each segment.
3. Have students work in groups or as a class to discuss the problem that the tree house detectives chose (making bikes more visible at night). Have students develop a list of pros and cons for the problem and guide students in a discussion to determine a class consensus on the validity of the problem. Extend the discussion to include other possible problems the tree house detectives could have chosen.

Careers

inventor
pilot
cyclist
bicycle repair person

4. Choose activities from the educator's guide and web site to reinforce concepts presented in the segment. The variety of activities is designed to enrich and enhance your curriculum. A class invention contest complements the program and reinforces the invention process. Activities are included to support such a contest.
5. Have students work individually, in pairs, or in small groups on the Problem-Based Learning (PBL) activity on the NASA "Why?" Files web site.

   To begin the PBL activity, read the scenario to the students.

   Read and discuss the various roles involved in the investigation. Have each student choose his/her role.

   Print the criteria for the investigation and distribute.

   Have students use the Research Rack located on the web site and the online tools that are available.
6. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess their understanding. In the beginning, students may have difficulty reflecting. To help students, give them specific questions related to the concepts to reflect upon.
7. The NASA "Why?" Files web site provides checklists and rubrics that may assist teachers in assessing students' understanding of the material presented.

Resources (additional resources located on web site)

Books

Flatow, Ira: *They All Laughed: From Light Bulbs to Lasers: The Fascinating Stories Behind the Great Inventions That Have Changed Our Lives.* Harperperennial Library, 1993, ISBN: 0060924152

Freedman, Russell; Wilbur Wright; Orville Wright: *The Wright Brothers: How They Invented the Airplane.* Holiday House, 1994, ISBN: 082341082X

Jones, Charlotte Foltz: *Mistakes That Worked.* Doubleday, 1994, ISBN: 0385320434

LaFontaine, Bruce: *The Story of the Wright Brothers.* Dover Publications, Inc., 2000, ISBN: 0486413217

McCormack, Alan J.: *Inventors Workshop.* Fearon Teacher Aids, 1981, ISBN: 0822497832

Wulffson, Don L.: *The Kid Who Invented the Trampoline: More Surprising Stories About Inventions.* Dutton Books, 2001, ISBN: 0525466541

Web Sites

NASA "Why?" Files
Come explore the NASA "Why?" Files web site and learn how six tree house detectives use Problem-Based Learning and scientific inquiry to solve mysteries in their community. After conducting research and experimenting in Dr. D's Lab, learn to be a detective yourself!
http://whyfiles.larc.nasa.gov

Wright Flyer Online Kids' Corner
Part of NASA's "Aero Design Team" web site has information on the Wright brothers and Wright airplanes. It includes contests for young people, special events, games, and even a comic book version of the Wright story.
http://quest.arc.nasa.gov/aero/wright/kids/index.html

Wright Brothers' Aeroplane Company & Museum of Pioneer Aviation
This comprehensive site with everything "Wright" includes pioneer aviation history, hands-on aviation adventures, virtual expeditions, and timely information. It even has a virtual hangar with six operational Wright aircraft. A "must see" for Wright brothers enthusiasts of all ages.
http://www.first-to-fly.com/

National Gallery for America's Young Inventors
The National Gallery for America's Young Inventors program was established to enshrine great inventions produced by America's youth. The National Gallery complements the efforts of the National Inventors Hall of Fame by inducting six young people in grades K- 12 annually. In this way, the National Gallery is taking the great ideas of American youth and preserving them forever.
http://www.pafinc.com/nat_gal.htm

INVENT AMERICA!
This nonprofit K-8 education program, launched in 1987, helps children develop creative thinking and problem-solving skills through a fun, unique, learning tool—inventing!
http://www.inventamerica.com/

Activities and Worksheets

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The Wright Brothers
Develop a time line of important events in the lives of Orville and Wilbur Wright 20

On the Web

Creations of the Imagination
Use your imagination to create crazy new objects from fruits and vegetables

Is It a Thingamajig or Thingamabob?
Create and build your very own thingamajig/thingamabob

* Activities for invention contest booklet

Let's Go Inventing

Inventing is fun and exciting, and everyone can be an inventor! An inventor is someone who thinks of new ways to solve problems in the home, community, or even the world. These solutions are called inventions. An invention is a new discovery, or it can be a new product. It can also be a process—a new way of doing things. Inventions come about in many ways. Most of the time, inventions happen because someone had to solve a problem, but sometimes inventions are the result of accidents. No matter how an invention is created, it is important that you keep careful records to make sure that you get credit for first having the idea.

There are a few simple steps to follow in the invention process. Use the checklist below to make sure that you are staying on track and protecting your invention!

- ❑ Keep a log. All inventors keep a log to record their work and their ideas. Keeping a log will prove that you had an idea first, and it will help you plan your invention.
- ❑ Use your imagination. Think wild and crazy thoughts. Remember that no idea is too silly. Everyone laughed at the Wright brothers and said that man would never fly. Good thing the Wright brothers didn't get discouraged!
- ❑ Look for problems that need solving. Look around you to find things that bug you or for things that would make life easier or better.
- ❑ Plan and design your invention. Careful design is important in the invention process. This is the time to brainstorm for ideas and to evaluate them.
- ❑ Research your invention to make sure that it has not already been invented and that it will work.
- ❑ Draw your invention. Make a detailed drawing of your invention so others will understand how your invention works.
- ❑ Make a model of your invention.
- ❑ Test your invention. If you have a working model, test it to see if it works as planned. If not, do more research, redesign it, and test it again. This procedure is called an iterative process.
- ❑ Name your invention. Every invention needs a name!
- ❑ Patent your invention. If you think your invention is one that others would want, contact the U.S. Patent Office.
- ❑ Share your inventions with others!

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Inventor's Log

Keeping a log is very important. It can prove that you had an idea first. It can also help you plan your invention and help you explain your invention to others when you are finished. Follow the suggestions below to help you keep a detailed and accurate log and become a true inventor!

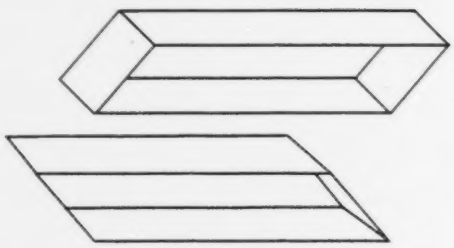
- Every time you work on your invention, take notes and record when and where you were when you had the thought. Also record the results of the work. Date and initial your notes.
- Describe all your ideas, plans, designs, models, tests, and results in great detail. Details are very important because they help others understand your invention.
- When possible, make a drawing of your ideas and your design. Be sure to label all the parts clearly and correctly so that others will be able to understand how your invention works.
- If you need to buy items to build your model, describe the materials and keep a list of the costs.
- Photos can be included in your log because they are excellent proof of your invention.
- Be sure to have an adult sign your log. He/she will be a witness to prove that the idea and work are your own.

Sample Log

Name: Wilbur Wright **Date:** February 12, 1902

Witness: Orville Wright **Time:** 10:02 AM

Location: Wright Bicycle Shop, Dayton, OH

Details	Drawings or photos
Discussed with Orville the problem of control. After observing the bicycle tube box, an idea came to me - Wing warping.	

Inventor's Log

Name: _____ **Date:** _____

Witness: _____ **Time:** _____

Location: _____

Details	Drawings or photos

Imagination Station

Anyone can be an inventor. All you need is a little imagination, ingenuity, and hard work. Your imagination is one of your most precious assets. Before you begin the invention process, loosen up your imagination by trying the activities below.

Take a Fantasy Journey

Have your partner close his/her eyes and read aloud the following fantasy journey.

> *Close your eyes and relax. Imagine yourself sitting on a beach. Watch the waves as they crash on the shore. Listen to the sound they make as they crash. Feel the Sun on your face. Do you hear the seagulls as they search for food? Imagine running your hands through the sand. How does it feel? Is it hot or cold, wet or dry, sticky or smooth? Imagine yourself building a sand castle. You wish you could see inside your castle. Suddenly, your body shrinks, and you are walking into the castle. What is inside? How many rooms are there? Imagine the people who used to live in castles long ago. What were they like? Now, just as suddenly as you shrank, you become big again. Your sand castle is wrecked. As you glance at the water, you notice that it has changed color. Imagine, in vivid detail, the color of the water. What creatures would live in an ocean that color? Imagine yourself swimming with them.*

Now, slowly open your eyes and illustrate your fantasy journey below.

Imagine and write your own fantasy journey:

Bugging Out the Bugs

Everyday we have things that "bug" us. These can either be problems that we encounter or they can be needs that are not met. For example, if you want to take your dog for a walk, you will NEED a leash to keep him from running away. Who invented the leash? Someone who needed one! If you wear glasses, it might really bug you that they are always lost. You buy a strap that holds your glasses around your neck so that you can always find them. Who invented that strap? Someone who was bugged because they kept losing their glasses! Inventing is that simple. So lets get started!

Take a look around your home, school, and community to see what bugs you or what you need to make life easier or more pleasant. Survey your family, friends, or classmates to see what bugs them and what needs they have. Don't worry about solving the problem, that will come later. To get started, ask yourself these questions:

1. What bugs me the most?

   At school: _____

   _____

   At home: _____

   _____

   During playtime or sports: _____

   _____

2. What chore or job can I make easier? _____

   _____

3. What thing(s) do I want to work better? _____

   _____

4. Can I make something easier to use? _____

   _____

5. Are there new ways to use things I already have? _____

   _____

Survey of family, friends, or classmates:

1. What bugs you the most?
2. What would make your job easier?
3. What is your biggest need?
4. What job or chore do you not want to do?
5. (Write your own questions.)

The Wright Brothers

Purpose

To create a time line showing the invention process of Orville and Wilbur Wright as they worked toward successful flight

Procedure

1. To create a time line on the adding machine tape, draw a vertical line 5 cm from one end of the tape.
2. Mark this line "1867" for the year that Wilbur Wright was born.
3. Use the ruler to measure and draw a line every 7.5 cm.
4. Label each line with the next consecutive year. See diagram 1.
5. Stop at 1948, the year Orville Wright died.
6. Research the life of Orville and Wilbur Wright. Be sure to take notes.
7. Discuss and decide with your group which events are important and place them on the time line.
8. Using colored pencils, illustrate the events. (optional)
9. Share your time line with the class and display for all to see.

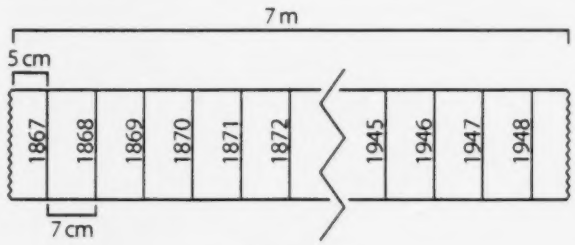
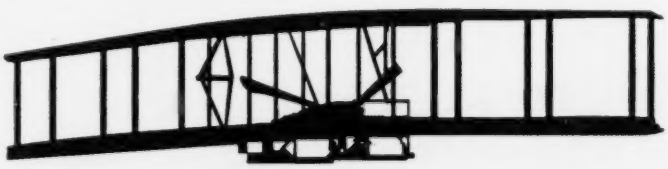


Diagram 1

Materials

adding machine tape
7 m long
pencil
ruler
colored pencils (optional)
reference materials such as books, encyclopedias, and internet web sites



The NASA "Why?" Files
The Case of the
"Wright" Invention

Segment 2

The tree house detectives visit the Lemelson Center in the Smithsonian National Museum of American History. They speak with Mr. Michael Judd and learn that anyone can be an inventor and that a "formal" education is not always required to be a great inventor. Determined to be inventors, the tree house detectives return to Dr. D's Lab to learn how to find a solution to their problem. Dr. D introduces them to brainstorming, and after brainstorming for ways to make their bikes more visible at night, the tree house detectives consult with Ms. Catharine Fay of NASA Langley Research Center in Hampton, Virginia. Ms. Fay helps the tree house detectives learn how to set criteria in order to evaluate their ideas. One of the tree house detectives even gets a little help from the Wright brothers in the evaluation process. After evaluating their ideas, the tree house detectives visit Dr. Joycelyn Harrison in her lab at NASA Langley Research Center to find out about reflective materials. The tree house detectives are sure they are now on their way to becoming famous inventors.

Objectives

The students will

- learn about various inventors throughout history.
- learn how to make proposals to solve a problem.
- learn how to evaluate their solutions by setting criteria.
- understand that scientists review and ask questions about the results of other scientists' work.

Vocabulary

brainstorming - looking for solutions to problems by coming up with many possible answers

criteria - standards on which a judgment or decision may be based

evaluate - to decide the value or worth of something after a study

patent - a written document that allows an inventor exclusive rights to make, use, or sell an invention for a number of years

reflective - capable of reflecting light, images, or sound waves

solution - an answer to a problem

Video Component

Implementation Strategy

The NASA "Why?" Files is designed to enhance and enrich existing curriculum. Full use of the video, resources, activities, and web site usually requires two to three days of class time per segment.

Before Viewing

1. Prior to viewing Segment 2 of *The Case of the "Wright" Invention*, discuss the previous segment to review the problem and to discover what the tree house detectives have learned about the invention process so far.
2. Review the list of issues and questions that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Focus Questions—Print the questions from the web site ahead of time to allow students time to copy them into their science journals. Remind students to look for the Focus Question icon as the answer to the focus question appears.

View Segment 2 of the Video

For optimal educational benefit, view *The Case of the "Wright" Invention* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Lead students in a discussion of the focus questions for segment 1 and record answers.
2. Have students discuss and reflect in their science journals the "What's Up?" questions asked at the end of each segment.
3. Choose activities from the educator's guide and web site to reinforce concepts presented in the segment. The variety of activities is designed to enrich and enhance your curriculum.
4. Review criteria, evaluate ideas, and then have students work in groups or as a class to discuss the solutions that the tree house detectives brainstormed. Have students develop a list of criteria for each solution and guide students in the evaluation process. Discuss each and come to a class consensus on the best solution. Extend the discussion to include other possible solutions the tree house detectives could have chosen.
5. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 5 on page 13 and begin the Problem-Based Learning activity on the NASA "Why?" Files web site. If the web activity was begun, monitor students as they research within their selected roles and review criteria as needed. Encourage use of the following portions of the online Problem-Based Learning activity:

Careers

engineer
designer
lawyer
museum curator
historian
aviator

Research Rack - books, internet sites, and research tools

Dr. D's Lab - online simulations and hands-on activities for home or class

Media Zone - interviews with the experts in this program

6. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess their understanding. If needed, give students specific questions to reflect upon.
7. The NASA "Why?" Files web site provides checklists and rubrics that may assist teachers in assessing students' understanding of the material presented. These items may be found in the "Tools" section of the educators' area.

Resources

Books

Egan, Lorraine Hopping: *Inventors and Inventions (Grades 4-8)*. Scholastic Trade, 1999, ISBN: 0590103881

Greenblatt, Jacquelyn A.: *Women Scientists and Inventors: A Science Puzzle Book*. Good Year Books, 1999, ISBN: 0673577287

Reid, Struan and Patricia Fara: *The Usborne Book of Inventors*. Scholastic, Inc., 1994, ISBN: 0590621750

Sobol, Donald: *Wright Brothers at Kitty Hawk*. Scholastic Paperbacks, 1989, ISBN: 0590429043

Sullivan, Otha Richard, James Haskins, Jim Haskins: *African American Inventors (Black Stars Series)*. John Wiley & Sons, 1998, ISBN: 0471148040

Thimmesh, Catherine: *Girls Think of Everything: Stories of Ingenious Inventions by Women*. Houghton Mifflin, 2000, ISBN: 0395937442

Web Sites

The Lemelson Center, Smithsonian Museum of American History
The Jerome and Dorothy Lemelson Center for the Study of Invention is a place to explore the exciting world of invention. Whether you're a student, teacher, inventor, or history buff, you'll find things you can use.
http://www.si.edu/lemelson/

Invention Dimension
Developed by MIT, this web site contains information on various inventors. The site has an "Inventor of the Week" and an alphabetical archive of past inventors.
http://web.mit.edu/invent/index.html

The National Inventors Hall of Fame
This site celebrates the creative and entrepreneurial spirit of great inventors. The creative genius of invention is showcased through exhibits and presentations that allow visitors to experience the excitement of discovery, creativity, and imagination.
http://www.invent.org/book/

The Internet Invention Store
Here's a really fun place to see some inventions. How about the "Remote Control Locator Device," which helps you find your lost TV remote control; all you do is clap your hands and it beeps to let you know it's hidden. You'll see pictures of each invention and get an idea of what is patentable.
http://catalog.com/impulse/invent

Totally Absurd Inventions
Totally Absurd Inventions explores the funnier side of our inventive spirit by featuring actual USA-patented products! Take a glimpse into the minds of geniuses. Indulge yourself and behold the most incredible patents in the world!
http://www.totallyabsurd.com/

Wacky Patent of the Month
This web site is devoted to recognizing selected inventors and their remarkable and unconventional patented inventions.
http://colitz.com/site/wacky.htm

Kites in the Classroom
This site suggests uses of kites in the classroom and includes kite guides for students and worksheets and plans for teachers.
http://www.aka.org.au/kites_in_the_classroom/

Activities and Worksheets

In the Guide

Who Invented That?
Learn about famous and not so famous inventors and their inventions. 25

Brain Brewing Storms
Learn to dream up new ideas. 26

What a Plan! *
Worksheet to help you plan your invention. 27

Criteria
Establish criteria for evaluating solutions to a problem. 28

Research, Research, and More Research *
Steps to help you research your ideas. 29

It's a High Flying Kite
Build your own kite. 30

On the Web

Would You Buy This Invention?
Learn to question and evaluate the results of other inventors' work.

* Activities for invention contest booklet

Who Invented That?

Purpose

To learn about famous and not so famous inventors and their inventions

Materials

reference books, encyclopedias, and web sites
paper
pencil

Procedure

1. Choose an inventor from the list below or pick one of your own.
2. Research the inventor and take notes on important and interesting facts about the person and the invention.
3. Share the information with your class or family by performing a skit, writing a report, creating a poster, or writing a newspaper article.

Inventors

Geradus Mercator
Evangelista Torricelli
Maria Mayer
Galileo Galilei
Hans Janssen
Leonardo da Vinci
Elmer Sperry
Henry Ford
Archimedes
Ruth Handler
Frank Epperson
Charles Darrow
Robert Fulton
Christopher Cockerell
Anders Celsius
Grace Hopper
Richard Drew
Elisha Otis
George Eastman
Erna Hoover
Albert Einstein
Dr. John Pemberton
Bette Nesmith Graham
Blaise Pascal
Margaret Knight
Isaac Newton
Alva Fisher
Sophie Germain
Stephanie Kwolek
Sonya Kovalevsky
Thomas Edison
Garfield Weston
Clive Sinclair
Ivan Sutherland

Notes

Brain Brewing Storms

Purpose

To study the process of thinking that enables inventors to dream up new ideas

Materials

variety of junk objects
box or bag for objects
pencil
paper
timer or clock

Procedure

1. Discuss the rules of brainstorming:
2. Accept all ideas—there are no silly or bad ideas.
3. Record all ideas.
4. Produce a large number of ideas for a greater chance of finding a "winner."
5. Dare to dream up wild and "far-out" ideas because they can often become practical ideas.
6. Set a time limit.
7. Have one student in the group reach into the box and pull out an object.
8. Set the timer and list all suggested ideas for possible uses of the object.
9. After time is called, use the brainstorm web below to categorize your ideas. If you need more space, use the back of this sheet.
10. If time permits, repeat with other objects.

Conclusion

1. Which ideas seem the most logical? Why? _____

_____

_____

2. Which ideas seem the most useful? Why? _____

_____

3. What criteria did you use to sort the ideas? _____

_____

_____

4. Were the ideas you listed first your most creative ideas? Why or why not? _____

_____

_____

5. Did any oddball ideas turn into useful ideas? How? _____

_____

_____

What a Plan!

Use this worksheet to help plan your invention, but don't forget to record your plans in your inventor's log!

Problem

_____

Solutions

List the top 5 solutions from your brainstorming:

1. _____
2. _____
3. _____
4. _____
5. _____

Criteria

Develop a list of criteria to aid in evaluating your ideas.

1. _____
2. _____
3. _____
4. _____
5. _____

Question

1. Ask yourself what makes a good invention? _____
2. Is it really a new idea? _____
3. Is it useful? _____
4. Will it be helpful to others? _____
5. Will it be reasonably priced so others can buy it? _____

Identify the Best Solution

After evaluating each solution or idea, choose the best one to solve the problem.

Verification

To help find out if your idea is a good one, conduct a survey. Survey your family and friends to get their opinions about your invention.

1. Do you think my invention will solve the problem?
2. Would you use my invention? Why or why not?
3. What would you pay for the invention?
4. (Write your own survey questions.)

_____

_____

_____

Criteria

Problem To establish criteria for evaluating solutions to problems

Materials

paper
pencil
criteria sheet
science journal
timer or clock

Procedure

1. With a partner or in a group, read the two examples.
   Example 1 - instead of thinking of shoes as protecting your feet from the ground, think of using something to protect the ground from your feet.
   Example 2 - instead of thinking about how you can carry peaches home from a store, think of how they can come to you - by delivery or by growing your own.
2. Decide which problem to solve and record it on your criteria sheet.
3. Using a timer or a clock with a second hand, brainstorm for ideas and possible solutions to the problem for 3-5 minutes. Record these ideas in your science journal and don't forget the rules for brainstorming!
4. Choose the top three ideas for evaluation and record them on the criteria sheet.
5. Determine the criteria list you will use to evaluate your ideas. Criteria can be anything. For example: inexpensive to make, easy to make, easy to use, and so on. Record your criteria on the criteria sheet.
6. On the evaluation grid for solution 1, using a scale of 1-5, with 5 being the best and 1 being the least, rank the solution according to how it meets each criterion.
7. Find the solution's total score by adding the numbers of points given to each criterion and record in the total ranking score column.
8. Repeat with the other two solutions and grids.
9. Determine which solution has the highest-ranking score. This solution should be pursued as a possible answer to the problem.
10. Discuss the pros and cons of the solution and present your solution to the class.

Criteria Sheet Evaluation Grid

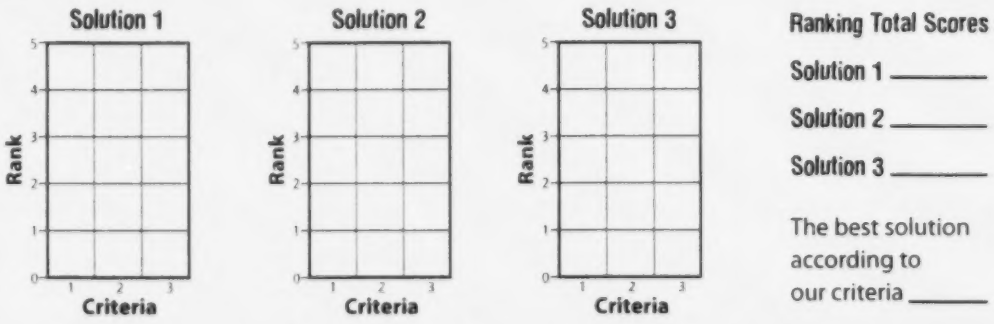
Problem _____

Solution 1 _____

Solution 2 _____

Solution 3 _____

Evaluation Grids



Ranking Total Scores

Solution 1 _____

Solution 2 _____

Solution 3 _____

The best solution according to our criteria _____

Research, Research, and More Research

Research is the gathering of facts and information that enables you to approach a subject with as much knowledge as possible. In the invention process, research is critical so that you have adequate knowledge to evaluate your idea. It is during this stage of the invention process that you should make changes in your invention or even decide to throw it out and start over. Don't be afraid to do whatever it takes to make your invention the best possible invention you can make!

Below, read the suggestions on how to research your invention. Brainstorm for ideas for each suggestion and plan your research carefully. Be sure to record your research in your Inventor's Log.

1. Research to see if your idea already exists:
   a. check retail stores
   b. check catalogs
   c. write or e-mail related businesses
   d. check with the U.S. Patent Office
2. Go to the library to research similar ideas or inventions.
3. Conduct an internet search for your invention.
4. Talk to experts in your community that might know of similar inventions.

Use the research collected and answer these questions to see if you are on track:

	YES	NO
1. Is my idea original?	❑	❑
2. Will my idea solve my problem?	❑	❑
3. Is my invention easy to make?	❑	❑
4. How will my invention work?	❑	❑
5. Is my invention useful?	❑	❑
6. Is my invention safe to use?	❑	❑
7. Is there an easier or better way to solve the problem?	❑	❑

If you answered yes to 1-6, you are on your way and ready to begin designing a model for testing!

EG-2001-10-04-LaRC

It's a High Flying Kite

Problem

To learn how to make a kite

Teacher Prep

Using a sharp knife, carefully make a deep notch on the ends of each stick.

Materials

thin twine/string
transparent tape or glue
102-cm X 102-cm sheet of strong paper
90-cm wooden dowel or stick
102-cm wooden dowel or stick
plastic bag
scissors
metric ruler
markers or crayons to decorate the kite

Procedure

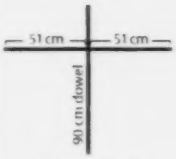


Diagram 1

Diagram 2

Diagram 3

Diagram 4

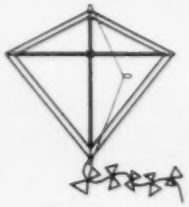


Diagram 5

1. Measure 51 cm from one end of the 102-cm dowel. Mark the spot with a marker or pencil.
2. Lay the 90-cm dowel across the top of the 102-cm dowel so that they form a cross at the spot marked above. See diagram 1.
3. Using string, tie the two sticks together, making sure that they remain at right angles to each other. To strengthen the connection, place a dab of glue at the joint.
4. Cut a piece of string long enough to fit around the kite frame and then add 10 cm.
5. On one end of the string, make a loop and tie a knot to secure the loop.
6. Place the string into the top notch of the kite frame, leaving the loop free. Wrap the string around the stick a few times to secure. See diagram 2.
7. Stretch the string through the notch in the cross piece and to the bottom notch (opposite of top with loop). Mark this point on the string. *Note: The string must be taut but not so tight that it makes the sticks bend.*
8. At that mark, make another loop and tie it off with a knot. Place the string with the loop into the bottom notch and secure by wrapping the string around the stick a few times.
9. Continue to stretch the string through the notch on the other end of the cross piece and back to the top. Tie off by wrapping the string around the dowel and tie off with a knot to secure. See diagram 3.
10. Cut off any excess string.
11. Decorate the center of your paper that will be used for the kite.
12. Lay the paper face down on a smooth flat surface and place the stick frame on top of the paper.
13. Cut the paper around the frame, leaving a 3-4 cm margin. For better accuracy, measure 3-4 cm from the frame and mark with a pencil; then remove the frame and cut along markings.
14. Fold the edges of the paper over the string frame and tape or glue it down, making sure that the paper is pulled tight. See diagram 4.
15. To make the kite's bridle, cut a piece of string about 125-cm long and tie one end of the string to the top loop.
16. Come down from the top about 1/3 of the way and make a small loop in the string just above the intersection of the two cross pieces. This section is where you attach the kite's string to fly the kite.
17. Tie the other end of the string to the bottom loop. See diagram 5.
18. To make a tail for the kite, cut a plastic bag into strips approximately 5 cm x 20 cm. Tie the strips to a piece of string, spacing them about 10 cm apart.
19. Attach the tail to the bottom loop.
20. Attach string to center loop of the kite's bridle.
21. Fly your kite and enjoy!

Just for Fun

Orville Wright was an expert at making kites. He often sold them to playmates for spending money. The children in the neighborhood loved his kites because they had such good flying qualities. That was because Orville made the frame so thin that it bent in the wind. Even though Orville was too young to realize that this curvature contributed greatly to the kite's good flying qualities, it aided him years later as he built kites that helped him to achieve successful flight.

The NASA "Why?" Files
The Case of the
"Wright" Invention

Segment 3

The tree house detectives are ready to test various reflective materials that will help make bicycles more visible and safer at night. They enlist help from a NASA "Why?" Files Kids' Club classroom in Riverside, Ohio, that shares their test results and the safety ratings they determined for fluorescent paint, a glow stick, neon pink poster board, and reflective stickers. After a visit to Dr. D's lab, the tree house detectives are ready to learn about designing their invention and building a model. They go to NASA Langley Research Center in Hampton, Virginia, to visit Marty Waszak to learn about iterative design and talk to Sam James to discover how models are built at NASA. The tree house detectives determine that their next step is to learn more about testing. While visiting the Wright Brothers National Memorial in Kitty Hawk, North Carolina, Jacob once again bumps into Orville and Wilbur Wright. As the brothers wait to test their glider on Jockey's Ridge, they help Jacob understand the importance of testing in the "Wright" conditions.

Objectives

The students will

- plan and conduct a simple investigation.
- employ simple equipment and tools to gather data and extend the senses.
- use data to construct a reasonable explanation and communicate the results.
- understand that light interacts with matter by transmission, absorption, or scattering (reflection).
- design a product.
- build a model of a product.
- understand that perfectly designed solutions to problems do not exist.

Vocabulary

design - features of shape, configuration, pattern or ornamentation that can be judged by the eye in finished products.

fluorescence - the giving off or the property of a substance that gives off radiation, usually as visible light when exposed to radiation from another source

glider - an aircraft without an engine that glides on air currents

iterate - to do something over again or repeatedly

prototype - an original model on which something is formed

microaerial vehicle (MAV) - a small aircraft not larger than 6 inches and capable of flying at speeds up to 25 mph. Inspired by insects and birds, these aircraft can be used for missions of surveillance and measurements in situations where larger vehicles are not practical.

model - a small but exact copy of something; a pattern or figure of something to be made

mold - the frame on, around, or in which something is constructed or shaped

replica - a copy that is exact in all details

scale model - the reduced size of a picture, plan, or model of an object, as compared to its actual size

Video Component

Implementation Strategy

The NASA "Why?" Files is designed to enhance and enrich the existing curriculum. Full use of the video, resources, activities, and web site usually requires two to three days of class time per segment.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the "Wright" Invention*, discuss the previous two segments to review the problem and discuss what the tree house detectives have learned about the invention process thus far. Use the problem board to help sort the information.
2. Review the list of issues and questions that the students revised and/or created prior to viewing Segment 2. Determine which, if any, were answered in the video or in the students' own research.
3. Focus Questions—Print the questions from the web site ahead of time to allow students time to copy them into their science journals. Remind students to look for the Focus Question icon as the answers to the focus question appear.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the "Wright" Invention* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. At the end of Segment 3, lead students in a discussion of the focus questions for segment 3 and record answers.
2. Have students discuss and reflect in their science journals the "What's Up?" questions asked at the end of each segment.
3. Choose activities from the educator's guide and

web site to reinforce concepts presented in the segment. The variety of activities is designed to enrich and enhance your curriculum.

4. Review and/or perform the classroom experiment on reflective materials and discuss the safety ratings determined by the students. Have students work in groups or as a class to brainstorm for ideas about how the various materials could be used to help make bikes safer at night. Discuss each idea and reach a class consensus on the best solution. Extend the discussion to predict how the tree house detectives will use this information and what their final design will look like.
5. Continue working on the Problem-Based Learning activity on the web site. Have students use the Research Rack and the experiments located in Dr. D's Lab. Visit the Media Zone to learn more about the experts that were interviewed in this segment. Check out some of the great web sites that are referenced.
6. Have students reflect in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon.
7. The NASA "Why?" Files web site provides checklists and rubrics that may assist teachers in assessing students' understanding of the material presented. These items may be found in the "Tools" section of the educators' area.

Careers

control engineer
aerodynamicist
wind tunnel engineer
technician
biologist
computer programmer
model builder

Resources

Books

Bender, Lionel: *Eyewitness Books: Invention*. Dorling Kindersley Publishing, Inc., 2000, ISBN: 0789457687

Krensky, Stephen: *Taking Flight: The Story of the Wright Brothers (Ready-To-Read)*. Simon & Schuster (Juv), 2000, ISBN: 0689812256

CDs

InventorLabs—Transportation
Enter the world of four great inventors who gave wings—and wheels—to all mankind. Meet the Wright brothers, Gottlieb Daimler, and George Stephenson and join them in their labs to explore their inventions: the flying machine, the Mercedes automobile, and the first practical locomotive, respectively. An interactive CD lets you use your ingenuity to build your vehicle. Published by Simon & Schuster Interactive, 2000, ISBN 0743522028

Web Sites

Aviation for Little Folks
Teach your students the parts of an airplane and how to fold a super-duper paper airplane with this NASA Educational Online Activity from NASA Spacelink. Designed for grades K-4.
http://spacelink.nasa.gov/Instructional.Materials/Online.Educational.Activities/Aviation/index.html

Wright Flyer Online
At this web site you will learn about the Wright Flyer Project, in which a full-sized replica of the 1903 Wright Flyer was tested in a wind tunnel at NASA Ames Research Center. Meet the people involved in the project, travel back in time to the early days of aviation, and use the activities to connect it all to the classroom.
http://quest.nasa.gov/aero/wright/

3M Collaborative Invention Unit
At this site, learn what it takes to be an inventor and explore being a scout, wizard, critic, and trailblazer. Take a look at other great inventors to find out if you have the "Wright" stuff to become an inventor.
http://mustang.coled.umn.edu/inventing/Inventing.html

The Tech Museum of Innovation
The Tech Museum of Innovation in San Jose, California, is a hands-on technology museum devoted to inspiring the innovator in everyone. Visit the teacher section for ideas and lesson plans or the discover section for online and interactive exhibits.
http://www.thetech.org/

To Fly Is Everything
This web site is one of the largest collections of Wright brother's information and activities. It includes a complete, original narrative about the invention of the airplane, all 301 Wright photos from the Library of Congress collection, a computer simulation of the Wright wind tunnel, brief biographies of all early aviators, and brief descriptions of airplanes.
http://hawaii.psychology.msstate.edu/invent

The CERES S'COOL Project
The CERES S'COOL (Students' Cloud Observations Online) Project invites schools around the world to make ground truth measurements for a NASA Earth-observing satellite mission.
http://asd-www.larc.nasa.gov/SCOOL/

Activities and Worksheets

To Reflect or Not To Reflect
Test various materials to determine a safety rating for night visibility. 35

Dazzling Doggie Designs
Use wacky objects to design an automatic dog feeder. 36

The Iterative Process *
Begin the iterative process for you own invention. 37

Spaghetti Anyone?
Practice building models by designing and building a freestanding spaghetti structure. 38

Model Making *
Guidelines to help you build a model of your invention. 39

Testing in the "Wright" Weather
Examine criteria the Wright brothers used for determining a good test area.

* Activities for invention contest booklet

To Reflect or Not To Reflect

Problem

To determine the most visible material for bike safety at night

Background

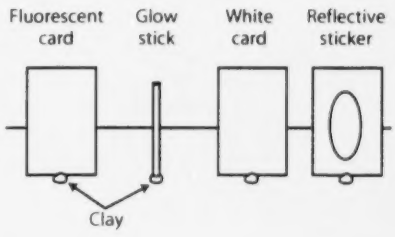
Reflective light is light that hits an object and then shines back. If an object is capable of shining by itself, it is said to "glow." Conduct research to learn more about reflective light and glowing light.

Materials (per group)

- neon pink construction paper or poster board 5 cm X 10 cm
- glow stick
- white poster board 5 cm X 10 cm
- fluorescent paint (any color)
- reflective sticker approximately 5 cm X 10 cm
- flashlight
- paint brush
- clay
- tabletop
- large box (approximately 60 cm X 60 cm) with one end cut out

Procedure

1. Using the paintbrush, completely cover the white poster board with fluorescent paint and let it dry.
2. Divide the clay into four equal parts and roll into small balls.
3. On a table place the clay balls in a straight line approximately 5 to 8 cm apart.
4. Open the glow stick and follow the package directions to start the chemical reaction that creates the glow.
5. Insert the four test items into the clay balls so that they stand upright.
6. Cover the test items with the cardboard box. To create a darker environment for a more accurate test, dim or turn off the lights in the room.
7. Turn the flashlight on and shine a beam of light on the first test item.
8. Observe and record your observations in the data chart.
9. Repeat steps 7-8 for each of the other test items.
10. After conducting the tests, determine the safety rating (1-5) for each test item. Use a rating of 1 if the item would have very poor visibility at night and a rating of 5 if it would be very visible at night.



Conclusion

1. Which item reflected light the best? _____
2. Which item created its own light? _____
3. Of these two items, which one would be the most visible material for bike safety at night?
   Why? _____
   _____
4. Is the most visible material the best choice for bike safety at night? Why or why not? _____
   _____
5. What are some other factors that would need to be considered before using this item for bike safety at night? _____
   _____
   _____
   _____

Dazzling Doggie Designs

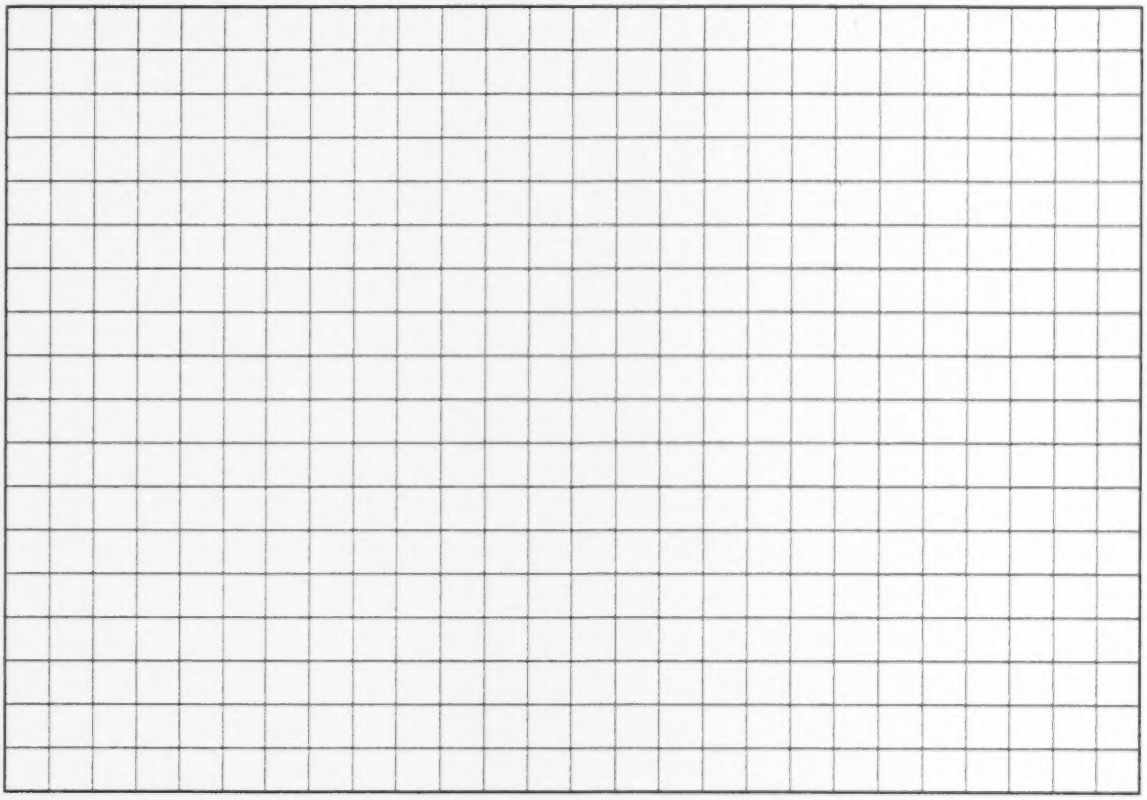
One part of the invention process is to carefully design your invention. It is important to design your invention with as much detail as possible. A well-designed invention will be easier for others to understand and easier to build.

Using the objects below, design an automatic dog feeder. Once you have determined your design, cut out the pictures and glue them onto a piece of construction paper to reflect your design. Use a pencil or marker to add additional details as needed.

The Iterative Process

The tree house detectives learned from Mr. Waszak that designing is an iterative process. Iterative means that first you design something, build it, test it, and then you analyze the data from the tests. From the data, the design is modified over and over again until it is correct. To begin the iterative process for your invention, carefully design and draw your invention. Remember to draw your invention in detail and label it clearly, neatly, and correctly so that others will understand how the invention works. In your Inventor's Log, draw a final copy and write a detailed description of your invention.

Draw your invention here:



Description of your invention: _____

_____

_____

_____

_____

_____

_____

_____

Spaghetti Anyone?

Problems

To practice building models
To build the tallest freestanding spaghetti structure

Procedure

1. Discuss in your group possible designs for the spaghetti structure.
2. Draw a design of your structure in your science journal.
3. Discuss any changes that need to be made to the design.
4. Draw the final design at the bottom of this page.
5. Using the masking tape to connect the spaghetti, create a model from your design drawings.
6. Measure and record the height of your structure.
7. Share your model with the class and compare heights to other models.
8. The tallest freestanding structure wins!

Materials

uncooked thick spaghetti
100 cm (1 m) of masking tape
scissors (to cut spaghetti)
science journal
pencil
metric ruler or meter stick

Name of Model: _____ Height: _____ cm

Designers: _____

_____

Model Making

It is time to make a model of your invention! Use the suggested list of ideas to help you make your model.

Before making a model, research model making. Visit the library for books on model making or conduct an internet search.

Think about the materials that you will need to make the model. What supplies will you need? How much will they cost? Be imaginative and creative in making your model. List the supplies needed below:

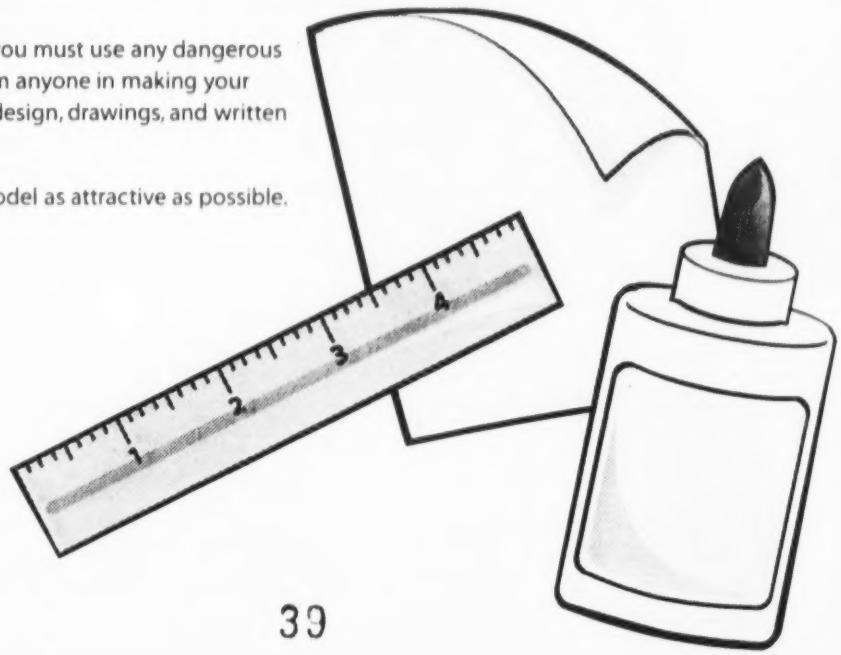
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

Look at your design carefully and in your Inventor's Log, write in detail the steps that you will follow to build your model. Writing out the steps will help you work out problems before you start the actual building process. This step will help save you time and money as it may prevent you from having to throw out the model and start over!

Solicit help from an adult if you must use any dangerous items. You may get help from anyone in making your model as long as your idea, design, drawings, and written description are your own.

- Try to make your finished model as attractive as possible.

Good luck!



The NASA "Why?" Files
The Case of the
"Wright" Invention

Segment 4

Remembering that Thomas Edison said, "Genius is one percent inspiration and ninety-nine percent perspiration," the tree house detectives decide not to give up on their invention despite all the problems. They decide to contact John Del Frate of NASA Dryden Flight Research Center at Edwards, California, to learn more about testing. The tree house detectives decide to do a little more testing and finally come up with an invention that works! They head to Dr. D's Lab to show off their invention and review the invention process. Dr. D encourages them to name their invention and tells the tree house detectives that they should protect their invention with a patent. To learn about patents, copyrights, intellectual property, trademarks, and trade secrets, the tree house detectives visit Ruth Nyblod at the U.S. Patent Office in Washington, DC. Back at the tree house, the detectives watch Mr. Textbook and decide to go to the Wright Brothers National Memorial at Kitty Hawk, North Carolina, where they speak with Ranger Darrell Collins. While there, the tree house detectives just happen to run into you know who—Orville and Wilbur Wright!

Objectives

The students will

- understand that scientific investigation involves asking and answering a question and comparing the answer with what scientists already know about the world.
- understand that scientists develop explanations by using observations.
- understand that scientists make the results of their investigations public.
- implement proposed solutions individually and collaboratively.
- communicate a problem, design, and solution, including oral, written, and pictorial communication of the design process and product.
- understand that people have always had problems and invented tools and techniques to solve problems.
- learn that scientists and engineers often work in teams.

Vocabulary

copyright - Protects the original expression of ideas, not the ideas themselves. It is free and automatically safeguards your original works of art, literature, music, films, broadcasts and computer programs from being copied and from certain other infringements.

intellectual property (IP) - IP represents the property of your mind or intellect. Types of intellectual property include patents, trademarks, designs, confidential information/trade secrets, copyrights, and so on.

inspiration - something that moves a mind to create

trademark - can be a letter, number, word, phrase, sound, smell, shape, color, logo, picture, aspect of packaging or any combination of these, which is used to distinguish goods and services of one trader from those of another

trade secret - Both a type of intellectual property (IP) and a strategy for protecting your IP. It includes proprietary knowledge (know-how) and other confidential information.

Video Component

Implementation Stratey

The NASA "Why?" Files is designed to enhance and enrich the existing curriculum. Full use of the video, resources, activities, and web site usually requires two to three days of class time per segment.

Before Viewing

1. Prior to viewing Segment 4 of *The Case of the "Wright" Invention*, discuss the previous three segments to review the problem and discover what the tree house detectives have learned about the invention process thus far. Use the problem board to help sort the information.
2. Review the list of issues and questions that the students revised and/or created prior to viewing Segment 4. Determine which, if any, were answered in the video or in the students' own research.
3. Focus Questions—Print the questions from the web site ahead of time to allow students time to copy them into their science journals. Remind students to look for the Focus Question icon as the answer to the focus question appears.

View Segment 4 of the Video

For optimal educational benefit, view *The Case of the "Wright" Invention* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. At the end of Segment 4, lead students in a discussion of the focus questions for segment 4 and record answers.
2. Have students discuss and reflect upon the

invention process, detailing how the process is similar to the scientific method.

3. Choose activities from the educator's guide and web site to reinforce concepts presented in the segment. The variety of activities is designed to enrich and enhance your curriculum.
4. Discuss the tree house detectives' final "invention" and create a list of how the invention will help or not help make bicycles and their riders more visible at night. Discuss design changes that could be made to improve the invention.
5. Complete the Problem-Based Learning activity on the web site.
6. Have students reflect in their journals what they have learned about the invention process.
7. If a class invention contest was held, have students present their final product. Invite parents and other classes to view the displays and inventions. You may want to invite engineers, science teachers, or other professionals to judge the inventions to determine a winner. Also, visit the NASA "Why?" Files web site for additional information on the mentoring program offered by the American Institute of Aeronautics and Astronautics (AIAA).

Careers

pilot
patent attorney
park ranger
hang glider pilot
astronaut

Resources

Books

Baker, David: *Inventions from Outer Space.* Random House, 2000, ISBN: 0375409793

Griffiths, Nick: *Incredible Inventions.* World Book Inc., 1996, ISBN: 0716617382

Web Sites

U.S. Centennial of Flight Commission
The Centennial of Flight Commission web site is filled with information for aviation enthusiasts, educators, and students to celebrate the Wright Brothers' first powered flight centennial on and around December 17, 2003. This site will be updating information continually.
http://centennialofflight.gov/

Inventing Flight
Founded in 1989, this web site promotes aviation, the Wright brothers, and especially the role of Dayton, Ohio, in the birth and future of aviation. Drawing from the rich history of the Wright brothers, Inventing Flight will launch a once-in-a-lifetime event culminating in the Centennial Celebration in July 2003.
http://www.inventingflight.com/

NASA Online Educational Activities
Students explore NASA through guided research, building models, planning space food menus, or tracking a hurricane through the Caribbean. The activities are ready for use in the classroom or computer lab and require minimal teacher prep time. In *A Century of Firsts*, students will research facts about the history of spaceflight in the 20th century and answer questions about selected events.
http://spacelink.nasa.gov/Instructional.Materials/Online.Educational.Activities/

Young Inventors Awards Program
Craftsman and the National Science Teachers Association (NSTA) challenges students to use creativity and imagination along with science, technology, and mechanical ability to invent or modify a tool. Awards include $250 to $10,000 in Series EE savings bonds for students and various merchandise rewards for teachers. Deadline for entry is mid-March 2002.
http://www.nsta.org/programs/craftsman/

Wright Brothers National Memorial Park
National Park Service web site for the Wright Brothers National Memorial Park in Kill Devil Hills, North Carolina.
http://www.nps.gov/wrbr/index.htm

NASA Glenn Research Center—Re-Living the Wright Way
Have fun while learning about the Wright brothers process of invention at this web site from NASA's Glenn Research Center. Choose from simulations, web casts, videos, and activities. The simulations about the forces of flight are excellent.
http://www.grc.nasa.gov/WWW/Wright/

AIAA Evolution of Flight
Are you looking for a good overview of the 100-year history of flight? Do you want it to be specific to your country? This site has a "dynamite" "History of Flight" section. Also check out the "Click and Learn" page.
http://www.flight100.org

NASA Spacelink
This web site offers a complete listing of NASA materials and web sites. From Spacelink you can obtain Innovation Through Engineering, a NASA educational poster containing metric activities associated with the Wright brothers' flight experiments. Activities include constructing and testing a sled kite, analyzing the data, and assembling a Metric Cube. The Process of Invention is another poster you will want to add to your collection. The poster traces the Wright brothers' story with examples of their experiments and inventions. It also contains an activity for constructing and testing a flying model glider.

U.S. Patent and Trademark Office Kids' Pages
Want to understand exactly what a patent is and how to get one? Did you know that the youngest patent-holder was a four-year-old girl? This site has some nifty information, games, and puzzles.
http://www.uspto.gov/go/kids/

Ippy Online
This web site from down under in Australia teaches children about innovations, inventions, and protecting good ideas through interactive games. Includes case studies, fact sheets, and lesson plans for teachers and lots of fun activities for students.
http://www.ippyonline.gov.au

Activities and Worksheets

In the Guide

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Build an effervescent car and perform test trials as you race down the track. 45

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On the Web

Testing 1, 2, 3
Build and test an egg drop apparatus.

Invention Protection
Learn about intellectual property, patents, and much more.

* Activities for invention contest booklet

3, 2, 1... Crash! Testing a Model

Purpose

Use measurement and ratios to perform test trials and predict outcomes of the trials.
Use graphing to organize data, interpret, and analyze results.

Teacher Prep

1. Use a small nail or sharp pen to puncture the center of the film canister or milk carton tops to create a small pilot hole for the wooden skewer.
2. Prepare the effervescent tablets in fractional sizes of one-half and one-fourth. To prepare the tablets, use the point of a sharp ink pen to score the top of the tablet by scratching a bisecting line across it and breaking along the line. Seal in a moisture proof container.
3. Optional: If graduated cylinders are not available for measuring, scratch the surface of a film canister or place tape at the appropriate location for 10 ml of water.

Procedure

1. Place the open end of the foam cup on a foam meat tray and trace.
2. Cut out the circle and tape it to the open end of the cup.
3. Cut a straw 7 cm long and tape the straw to the rim of the front end of the dragster. See figure 1.

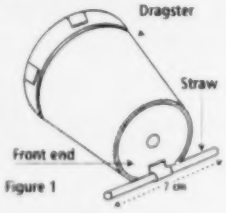


Figure 1

4. Cut a second straw 13 cm long and tape the straw to the bottom of the back end of the cup so that the straws are parallel to each other and close to the rim at each end. See figure 2.
5. Thread a skewer through each straw and break off or cut the ends so that 2 to 3 cm of the skewer extend beyond the straw on each side.
6. Push a cap wheel onto the skewer on each side of the straw, leaving a small gap between each wheel and straw, thus allowing the wheels to roll.
7. Tape a straw to the bottom of the cup, perpendicular to the other two straws so that it extends about 4 cm beyond the wheel axle. See figure 3.

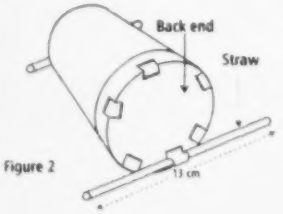


Figure 2

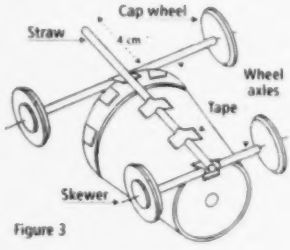


Figure 3

Propulsion Device

1. To construct the propulsion device, mark an "X" in the center of the end of the shoe box and glue a 5-cm section of Velcro® to the location of the "X." See figure 4.
2. Glue the opposing side of the Velcro® to the bottom of the film canister; trim as needed.
3. On the opposite end of the shoe box from the Velcro®, cut the back seams and pull down the flaps so that they lie flat.

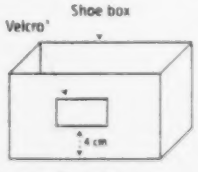


Figure 4

Materials

6-8 oz foam cup
foam meat tray (9 cm X 7 cm)
pen or marker
tape
3 straws
3 wooden skewers
4 round film canister tops or plastic milk carton tops
shoe box
scissors
Velcro® strip with adhesive back (5 cm X 3 cm)
masking tape
meter stick
effervescent antacid tablets
paper towels
water
graduated cylinder (optional)
safety goggles

3, 2, 1... Crash! Testing a Model (continued)

4. Poke a skewer through the front end of shoe box close to the bottom of the box and centered directly beneath the Velcro® strip, extending the skewer about 12 cm beyond the edge of the box. See figure 5.

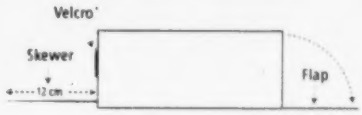


Figure 5

Test Track

1. To make the test track, cut two pieces of masking tape: one piece for the starting line (1 m long) and a second piece (5 m long) to measure the distance the dragster travels.
2. Place the masking tape at a right angle on the floor.
3. Mark the longest piece of tape in increments of decimeters.

Trials

1. Begin trials by placing the dragster behind the starting line.
2. Align the shoe box behind the dragster. Slide the skewer on the box into the straw on the bottom of the dragster.
3. Adjust the dragster and shoe box behind the starting line so that the wheels of the dragster align with "zero" on the marked tape.
4. Place your foot into the shoe box to hold it in place during the test. Adjust the box and dragster as needed. See figure 6.
5. PUT ON SAFETY GOOGLES. Fill the film canister with 10 ml of water and hold it near the front of the shoe box.
6. Predict how far the dragster will travel with one-fourth of a tablet added to the water. Record your prediction in journal.
7. Drop one-fourth tablet into the canister and snap on the cap.
8. Quickly attach the canister to the Velco® on the shoe box.
9. Position the dragster to rest against the film canister. STAND BACK DURING BLAST OFF.
10. Measure the distance that the dragster traveled (use the front wheels for mark) and record in journal.
11. Rinse and dry the canister.
12. Repeat steps 4-10 for a second trial of one-fourth tablet.
13. Find the average distance the dragster traveled for the two trials.
14. Repeat steps 4-10 with other ratios of tablets.
15. Graph results for each ratio.
16. Analyze your data and determine which ratio produced the greatest distance.

Figure 6

Extension

1. Construct a dragster from a soda can or plastic water bottle. Use vinegar and baking soda as a propulsion mixture. Begin with a ratio of 200 ml vinegar to 16 g baking soda.
2. Research aerodynamics. Design and construct a more aerodynamic dragster. Compare the test results with the results of the original dragster.

Trademarks

Purpose

To have a basic understanding of trademarks

Materials

magazines
glue
scissors
construction paper
markers or crayons

Background

A trademark can be a letter, number, word, phrase, sound, smell, shape, color, logo, picture, aspect of packaging, or any combination of these that is used to distinguish goods and services of one trader from those of another. A small "TM" designates a trademark. When an inventor applies for a trademark, the TM designation is used as a superscript to the product name. Once the trademark has been registered, the superscript ® appears at the end of the product name. Example: Velcro™, Velcro ® **http://www.uspto.gov**

Procedure

1. Find pictures of trademarks in the magazines and cut them out.
2. Position the trademarks onto a piece of construction paper and glue them on.
3. Use markers or crayons to fill in the gaps, repeat the logos, and so on.
4. In your own words on the back of your collage, define trademark.
5. Share your collage with your class.

Extensions

1. Design an original trademark for your invention or other product.
2. Use a computer program to design an original trademark.
3. Use your name and create an original trademark.
4. Look at various company logos such as Disney, Barbie, Nintendo, Lego, Pokemon, Apple Computers, and Visa. Create a company logo for an imaginary company you would like to own someday.

Copy Cat or Copyright?

Purpose

To explain copyright and recognize a copyright symbol

Materials

Haiku poetry samples
pencil
paper
art paper
markers or crayons

Background

Copyright protects the original expression of ideas, not the ideas themselves. It automatically safeguards your original works of art, literature, music, films, broadcasts, and computer programs from copying and certain other uses.

The copyright protects the form of expression rather than the subject matter of the writing. For example, a description of a machine could be copyrighted but would only prevent others from copying the description; it would not prevent others from writing a description of their own or from making and using the machine. Copyrights are registered by the Copyright Office of the Library of Congress. **http://lcweb.loc.gov/copyright/**

Procedure

1. Using the Internet or books, research the background of Haiku poetry.
   http://www.hsa-haiku.org
   http://www.haiku.cc
   http://www.tecnet.or.jp/~haiku
2. Take turns in your group reading samples of Haiku poetry.
3. How many syllables are in the first line? Second line? Third line?
4. Discuss Haiku poetry and its purpose.
5. Write a Haiku poem and share it with your group for editing.
6. If necessary, revise your poem.
7. Discuss how to protect your original poem from someone copying your work.
8. Look in various books, newspapers, and magazines to find copyright information. What is the symbol that lets the reader know the material is copyrighted?
9. Copy your poem onto art paper and illustrate.
10. Place the copyright symbol (©), along with the year and your name, on your original work of poetry and art.

Naming Your Invention

You have an invention and now you need to name it. The name you give your invention is important. A creative name will show people how creative you are. A name can make people interested in your invention by catching their eye. The right name will even help people remember your invention for all time! Give it a lot of thought; however, an invention's name can be changed at any time.

There are many ways to name an invention. Below are some ideas to help you think about naming your invention. Read the examples and then put some thought into creating a name for your invention using each idea. After completing all the suggestions, choose the one you like best.

An invention is often named for what it is made of, for example: ice cream, popcorn, corn meal, rubber cement, shredded wheat, and down coat.

Possible name for your invention: _____

Inventions are sometimes named after the inventor, for example: Singer Sewing Machine, Morse Code, *Wright Flyer*, John Deere Tractor, Ford Truck, Heinz Ketchup, and Ferris Wheel.

Possible name for your invention: _____

Some inventions are named for their function (the way they work), for example: hair dryer, toothbrush, sunglasses, roller blades, hairbrush, screwdriver, space shuttle, and frying pan.

Possible name for your invention: _____

A funny or clever name will often make people remember an invention, for example: Silly Putty, Flip Flops, Beanie Babies, and Cool Whip.

Possible name for your invention: _____

Descriptive, rhyming names and abbreviations are also unique ways to name your invention, for example: VCR, TV, CD player, Rosy Posy, Curious George, and GI Joe.

Possible name for your invention: _____

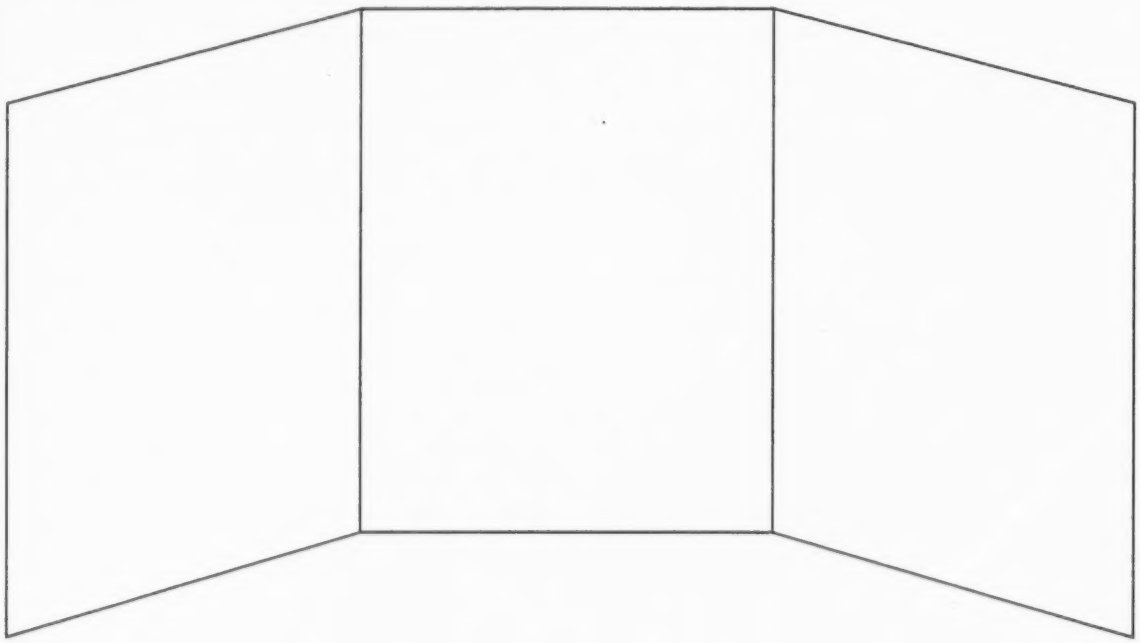
My invention's name is : _____

EG-2001-10-04-LaRC

Displaying Your Invention

1. To display your invention, make a backboard or poster that outlines all the steps that you took during your invention process.
2. To make a backboard, use two pieces of poster board and cut one in half.
3. Tape the pieces you cut in half to the larger piece of poster board to form the side panels.
4. Design the layout of any photographs or illustrations that you want to include. Be sure to make the display bright and colorful.

Design Layout



5. On your display include the following:
   - your name
   - the title of your invention
   - the purpose of the invention
   - diagram of your invention with all parts labeled
   - an explanation of how your invention works
   - any photos or other information that would be useful to understand your invention
   - optional: biography of the inventor, jingles, advertisements, songs, or poems about your invention, and the results of your research
6. Set up your display, model, and inventor's log for all to enjoy!

The Incredible, Edible *Wright Flyer*

Purpose

To create a model of the Wright Flyer

Materials

3 full-sized graham crackers
12-14 small pretzel sticks
frosting
paper plate

Procedure

1. Following the perforations on the graham cracker, break one of them into four pieces. Set aside.
2. To build the wings of the plane:
   Dip a pretzel into the frosting so that you have a small amount of frosting on both ends. The frosting will act as glue.
   Place the pretzel in a perpendicular position on one corner of a full-sized graham cracker. Make sure that it is firmly attached by the frosting.
   Continue to dip pretzels into the frosting and place them on the graham cracker, as shown in diagram 1.
   Once you have all eight pretzels properly placed, put the second full-sized graham cracker on top. Press slightly to make sure that the frosting sticks.
3. To build the remaining section of the plane:
   Break two pretzel sticks in half.
   Dip both ends of one of the pretzels into the frosting.
   Place the pretzel in a perpendicular position on a corner of one of the graham cracker sections that you set aside in step 1. Repeat with the other three pretzel halves. See diagram 2.
   Once you have all four pretzels properly positioned, place a second graham cracker section piece on top. Press slightly to make sure that the frosting sticks.
4. To connect the two sections, dip two pretzels in frosting and attach the wings to the other section as shown. See diagram 3.

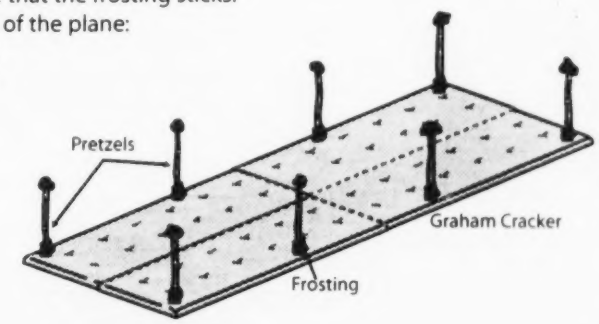


Diagram 1

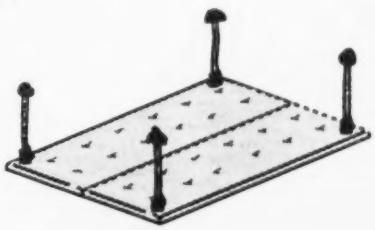


Diagram 2

Extension

Conduct an internet or library search for additional information on the Wright brothers' airplanes. Information may include how many different models they built, how their airplane changed with each model, or why they made changes to each plane.

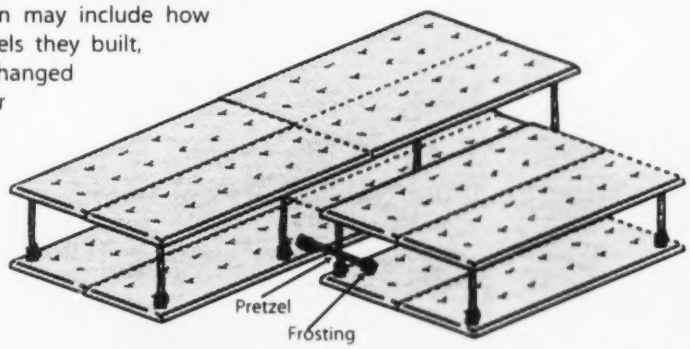


Diagram 3